30th Congress, 1st Session. [SENATE.] Executive, No. 73.

LETTER

FROM THE

THE SECRETARY OF THE TREASURY,

COMMUNICATING

The report of the superintendent of the construction of standard weights and measures.

August 12, 1848.

Ordered to be printed, and that 500 additional copies be printed for the superintendent of weights and measures.

Treasury Department, *August* 12, 1848.

Sir: I have the honor to transmit, herewith, a report on the progress made in the construction of standard weights, measures, and balances, during the years 1846 and 1847, under the superintendence of Professor Alexander D. Bache.

All of which is respectfully submitted:

R. J. WALKER,
Secretary of the Treasury.

To the President of the Senate.

Report to the Treasury Department, by Professor Alexander D. Bache, on the progress of the work of constructing standards of weights and measures, and balances, in the years 1846 *and* 1847.

Office of Weights and Measures,
Washington, July 30, 1848.

Sir: In April, 1846, I had the honor to submit to you a report on the progress of the work of constructing standards of weights and measures, and of balances, up to the first of January of that year.

The preliminary investigations for this work were made by F. R. Hassler, esq., under a resolution of the Senate of 1830. In 1835, Mr. Hassler commenced the actual construction of standards of weights and measures for the custom-houses of the United States. In the following year the Treasury Department was directed, by a

joint resolution of both Houses of Congress, to have a set of standards made for each of the States; and in 1838 the construction of standard balances for the States was ordered by the same authority. This work, as a continuation of that already ordered, was under the direction of Mr. Hassler, who, previous to his lamented decease, in November, 1843, had made very considerable progress in its execution. Besides the preliminary inquiries by Mr. Hassler, and the preparation of materials, drawings, patterns and machinery, the standard weights for the States and for the custom-houses had been made, adjusted, and delivered. Nearly one-half of the capacity measures had been finished, and the rest were in different stages of progress. Between one-fourth and one-third of the measures of length had been completed; the others were in progress; and the balances for the States had been commenced. In January, 1844, I took charge of this unfinished work, and in February, Joseph Saxton, esq., then of the United States mint, was, on the resignation of Edward T. Hassler, esq., appointed assistant and foreman.

The number of mechanicians and laborers already employed, (seven of the former and six of the latter,) determined the scale upon which the work was to be done. There remained for completion the capacity and length measures, and the balances; the adjustment and comparison of the length measures; the adjustment of the measures belonging to the scientific portion of the work, and the construction of the balances to the mechanical part.

In 1844 the adjustment of the gallon measures was completed, and capacity measures were adjusted for the ordnance department. The work on the balances was estimated to have advanced about one-seventh towards completion. The old base apparatus for the coast survey was compared anew with the standards. The estimate of progress on the balances, given in my report for 1844, is probably from two to three per cent. too great; being, according to the more correct data which have accumulated since, nearer one-eighth than one-seventh. In the report just referred to, a statement of the weights and measures, made by Mr. Hassler, and of the work on the balances, under his direction, was given in detail.

In 1845 the adjustment of the half bushel measures was completed, and the detailed tables of the adjustment given, in the report for the year. Five balances of the former pattern were altered to the new, and the progress in the whole work, during the year, was estimated at about one-seventh. This, also, would be more correctly stated at one-eighth. The balances for the States of New York and New Jersey were delivered and set up by Mr Saxton, in the State houses at Albany and Trenton, in 1845; and early in 1846 the adjustment of a new base apparatus for the coast survey was commenced.

In 1846 the adjustment of the new base apparatus was continued. The process required the application of much patient mechanical skill, as well as of exact scientific research. The mechanicians were employed almost exclusively, during this time, on the balances for the States, and the work required no special report. A particular

account of the progress, during this year and the following, (1847,) will be given in the present report.

In 1844 I was requested by the then Secretary of the Treasury, the Hon. John C. Spencer, to superintend the experiments necessary for the comparison of hydrometers, in reference to their use in the collection of the revenue; and subsequently the Treasury Department made a similar request, in regard to the investigations required by an act of Congress of 1843, in relation to sugar, molasses, syrups, &c. These were both extra-official calls, answered without a view to emolument, with the desire to render previous studies and pursuits useful to the country. Professor R. S. McCulloh was named to conduct the researches, under my direction. Three elaborate reports have been presented by Professor McCulloh on this subject; the first in 1845, the second in 1847, and the third in 1848; the collection and reprinting of which have been recently ordered by the Senate of the United States.

The report on hydrometers recently presented concludes all the necessary preliminary matter upon that subject for the action of the department. Specific recommendations will be at once made, founded upon this report, intended to procure the uniformity of examination at different custom-houses, which is very desirable, and which does not now exist. As this whole subject has been presented in detail in separate reports, I merely refer to them in the present one.*

The full set of standards of weights and measures supplied from this office, for the States, consist of—

1. A set of weights from 1 lb. avoirdupois to 50 lbs., and a troy pound.
2. A set of weights from 1 oz. troy to 1 ten-thousandth of an ounce.
3. A yard measure.
4. A set of liquid measures consisting of the gallon and its parts, down to the half-pint, inclusive.
5. One half-bushel measure.

The following twenty-one States have each received a full set of standards:

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*The titles and dates of these reports are as follows:

1. A report of chemical analysis of sugars, molasses, &c., and of researches on hydrometers, made, under the superintendence of Professor A. D. Bache, by Professor R. S. McCulloh, February 17, 1845, Senate doc. 165, 28th Congress, 2d session.

2. A report of scientific investigations relative to the chemical nature of saccharine substances, and the art of manufacturing sugar, made, under the direction of Professor A. D. Bache, by Professor R. S. McCulloh, February 27, 1847, Senate 209, 29th Congress, 2d session.

3. Second report on inquiries and researches relative to hydrometers, &c., made, under the superintendence of Professor A. D. Bache, by Professor R. S. McCulloh, May 29, 1848.

There are two reports from the Treasury Department, dated June 15, 1844, and July 31, 1846, relating to this subject. The first communicating copies of regulations in relation to the importation of foreign sugar and molasses—Senate doc. 12, 28th Congress, 2d session. The second relative to frauds in recent importations of sugar and molasses, from the West India islands, and the measures necessary to prevent their recurrence—Senate No. 467, 29th Congress, 1st session.

1. Maine,
2. Massachusetts,
3. Vermont,
4. Rhode Island,
5. Connecticut,
6. New York,
7. New Jersey,
8. Pennsylvania,
9. Delaware,
10. Maryland,
11. Virginia,
12. North Carolina,
13. South Carolina,
14. Georgia,
15. Alabama,
16. Michigan,
17. Ohio,
18. Kentucky,
19. Illinois,
20. Missouri,
21. Arkansas.

The standards of liquid and day measures remain at the Treasury Department, subject to the call of the executives of the States of (22) New Hampshire and (23) Tennessee, the other standards having been received by those States.

The smaller weights, and the standards of liquids and dry measure, yet remain subject to the call of the executive of (24) Louisiana.

The small weights, the yard measure, and the liquids and dry measures, are yet to be called for by the executives of (25) Indiana and (26) Mississippi.

Orders have been received within the year to prepare standards for Florida, Texas, Iowa, and Wisconsin. The executive of Texas having called for the standards for that State, arrangements have been made, as elsewhere stated, to forward them, leaving the standards for the States and custom-houses of Florida, Iowa, and Wisconsin, and for the custom-houses of Texas, to be prepared.

The gallon and half-bushel measures adjusted or verified by me, and for the accuracy of which I am responsible, are marked with the letter B. The same course will be followed with the other standards issued.

It appears, then, that of the thirty States twenty-one have received the standards necessary to prepare their county standards. Six of these have also received balances by which to adjust the weights and the liquid measures, available also for adjusting smaller dry measures, and two will soon receive them. A sufficient number of balances are now ready to meet the demand from the other States of this list, so that it may be assumed that, within the year, they may, if their attention is turned to it, receive all the means necessary for the issue of county standards.

Uniformity of weights and measures in actual use is the end designed by this distribution of standards to the States and to the custom-houses of the United States. It is expected that copies of the standards of weights and measures will be distributed by the State authorities to the counties, by the counties to the towns, townships, districts, parishes or sections. Each small sub-division having thus its standards, the sealers of the measures in ordinary use have adequate means for insuring general uniformity. In many of the States, the distribution of county standards is all that is necessary for the present, sealers of the weights and measures for the counties only being provided by the State laws.

The original standards must, of course, be made with extreme care, and all the resources of science and art of the day must be employed in their construction and adjustment. The copies for the counties should also be made with care, and of the same materials as the original standards. In the copies from these, by which the measures in ordinary use are regulated, the minor precautions may be omitted, and cheaper materials used. With the utmost precaution, a certain range of error is to be found in the original standards, and this goes on increasing as copies are made from copies. If the originals were not as accurate as they could be made, the copies of copies would be entirely wanting in uniformity. Our measures in common use show that this result is but too frequent.

The material of the State standards is brass, composed of an alloy of three parts, by weight, of copper, and one of zinc. The county standards should be of similar material and form with these. In addition, the parts of a bushel, the sub-divisions of the dry measure standard, should be furnished, if the distinction between liquid and dry measures is kept up. The copy of the avoirdupois weights, the pound and its multiples, and the sub-divisions of the pound, in ordinary use, would complete the set. The question has been asked of me, why the sub-divisions of the bushel and of the avoirdupois pound were not furnished from the office. I am of opinion that *when the arrangement* (it can hardly be called a system) *of weights and measures in common use is adopted, as that upon which the standards should be furnished, there should be in the details a thorough conformity to that system.* Accordingly, the sub-divisions of the dry measure standard (the bushel) and the usual sub-divisions of the avoirdupois pound should be so furnished; and I recommend the subject to the consideration of the department. For the same reason, I consider that the ordinary sub-divisions of the yard, the foot, inch, line, and decimal of an inch, should be marked upon the standards.

The county standards should be adjusted with care and scientific skill. The corrections for temperature should be applied to the length measure, or else temperatures near the standard be used in adjusting. The capacity measures should be adjusted by the weight of water which they contain, and between the temperatures of 39° and of 52°, when the expansion of brass and water are nearly alike. The balances furnished by the United States, will serve for the adjustment of the weights; of the gallon and its parts; and of the smaller sub-divisions of the bushel.

It would certainly be desirable that the standards for the towns, townships, parishes, or sections, should have a common origin, and be supplied under State authority. The material might be a cheaper one than that in the county standards; iron being substituted for brass. The length measure might be a simple iron bar, the foot and inch being marked on it by lines. When expense was not objectionable, the form and materials of the county standards might be repeated for the towns. A balance should also accompany the standards. The weights might be of iron, turned, polished and lacquered, with a cavity, closed by a plug screwing in, to admit of

adjusting by wire. The capacity measures should be adjusted by the weight or bulk of water which they contain, and between the temperatures of 39° and 52°. No covers or striking plates need accompany these standards, though such a plate should be used in adjusting them.

By these standards, the weights and measures in common use would be examined by the sealers in the usual way, using small seed instead of water, for adjusting the capacity measures, and striking with a straight edge of wood. The square which accompanies the State standards of length, and by which a wooden rod, held in a position parallel to the standard by wedges, can be divided by the lines upon the standard, is a convenient and simple arrangement for copying.

In every State of the Union, there are men connected with scientific professions or with literary and scientific institutions, who would direct the construction of county and town standards, or verify them when made. The work thus done once, would not require, for a series of years, to be touched.

No one who has discussed the subject of weights and measures in our country has considered the present arrangement as an enduring one. It has grown up with the growth of European society, and is deficient in simplicity and in system. The labor which is expended in mastering the complex denominations of weights and measures is labor lost. Every purpose for which weights and measures are employed, can be answered by a simple and connected arrangement. This is independent of the question of decimal or duodecimal subdivisions. That also is an important question, but one upon which there is a difference of opinion. It is also independent of the question of the most suitable natural standard or unit upon which to found a system.

In our own country the present arrangement of weights and measures has been considered by the great names who have written upon it as temporary. In 1790, Mr. Jefferson presented two plans to the House of Representatives, in one of which existing denominations are confirmed, the weights, capacity, and length measures are connected, and a scientific basis is proposed; in the other, the decimal system is introduced, the denominations are simplified, and the length measure is referred to a natural standard. Mr. Jefferson remarks: "The experiment made by Congress, in the year 1786, by declaring that there should be one money of account and payment throughout the United States, and that its parts and multiples should be in a decimal ratio, has obtained such general approbation, both at home and abroad, that nothing seems wanting but the actual coinage to banish the discordant pounds, shillings, pence, and farthings of the different States, and to establish in their stead the new denominations. Is it in contemplation with the House of Representatives to extend a like improvement to our measures and weights, and to arrange them also in a decimal ratio? The facility which this would introduce into the vulgar arithmetic, would, unquestionably, be soon and sensibly felt by the whole mass of the people, who would thereby be enabled to compute for

themselves whatever they should have occasioned to buy, to sell, or to measure, which the present complicated and difficult ratios place beyond their computation for the most part."

Either of the systems proposed by Mr. Jefferson would have changed the ordinary measures in use, although not the denominations.

The French system went much further, establishing a new unit, with decimal subdivisions and multiples, superficial and capacity measures referring to the same unit, and with similar subdivisions and multiples, and weights, (connected through the weight of a certain bulk of distilled water with the linear unit,) with also decimal multiples and subdivisions.

Small changes in weights and measures do not seem to me desirable; they disturb uniformity without effecting any marked good. Such are changes in the actual length of the yard or foot, in the temperature at which the measure is a standard, the use of decimal subdivisions of the yard, and the like. Some simplifications might with advantage be introduced, as the use of but one pound and its multiples and sub-divisions, the use of one unit of capacity measure instead of the liquid and dry measures. Such a system was proposed by Professor Renwick, of Columbia College, for adoption by the State of New York.

In 1819, a committee of the House of Representatives* proposed to adopt absolute standards conforming to the weights and measures in common use; to obtain, through a commission, copies of the yard, the bushel, the wine gallon, and the pound, supposed to conform to those in common use in the United States; to preserve these standards, and to distribute copies of them; to compare the length measure with the length of the second's pendulum, and also with that of an arc of the terrestrial meridian; to connect them by determining the weight of a certain bulk of distilled water; to define the bushel and gallon by the weight of water which they contain. It is, in effect, this system which has been carried out by Mr. Hassler.

In the learned report of Mr. Adams, (presented to Congress in 1821,) the system proposed is provisional in its character; his recommendations are—

1. To fix the standard with the partial uniformity of which it is susceptible for the present, excluding all innovations.
2. To consult with foreign nations for the future and ultimate establishment of universal and permanent uniformity.

The first proposal desirable and practicable at the moment, as producing uniformity in our country, was not to prevent the accomplishment of that more desirable system of uniformity throughout the world, when it should become practicable. The circumstances and sub-divisions of nations at that time did not prevent

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* Hon. Mr. Lowndes, chairman.

Mr. Adams from looking with expectation to the future; has the time now come for urging onward this proposition?

In the great movements among the nations of Europe, one object brought forward as presenting a beneficial result of union is uniformity in money, weights, and measures. In 1821, Mr. Adams proposed that the President of the United States should communicate with foreign governments to introduce a union in the system of weights and measures, so as to produce a uniformity throughout the principal nations of the world. The present time seems especially to invite an effort of this kind. In England, the subject of weights and measures is under consideration by a commission, and on the continent the new relations of States, hitherto separated, appear to be favorable to this object. Such changes could readily be effected by suitable means in one generation, by introducing the new measures through the elementary schools.

Mr. Hassler obviously considered the work which he had to perform as one not admitting of extensive alterations, even if desirable. In a paragraph, in which he speaks commendingly of the "success and advantages" of the French system, he says: "In the present operation, the aim could only be to determine a certain fundamental unit in each kind, the type of which is, in general, given by the habits of the country, and to determine the differences, or ratios, of all weights and measures that come under consideration with these or their multiples or subdivisions."

That this provisional system, by tending to produce uniformity throughout the United States, has been a gain, is not to be doubted; nor is it inconsistent with an ultimate purpose of greater good, to adopt a temporary means of less usefulness. It would be most unwise, because we hoped to effect general uniformity at a distant day, to neglect to provide for local uniformity in the present.

I invite the attention of the Treasury Department to this branch of the subject with the more confidence that the secretary has considered a reference to system in weights and measures worthy of notice in his last report (1847) to Congress.

Information has been frequently asked, especially during the past two years, as to the origin and value of the standards of weights and measures which have been distributed, under authority of the Congress of the United States, and in regard to the legal enactments concerning them.

The standards of weights and measures, made in part or in whole, under the direction of F. R. Hassler, esq., whose work has been merely continued by me, have the following origin:

1. The *actual standard* of length, the original of which the State standards are copies, is a brass scale of eighty-two inches in length, prepared for the survey of the coast of the United States, by Troughton, of London, and deposited in the office of weights and measures.

The copies or standards made for the Treasury Department, the States, the custom-houses, &c., being of brass, the temperature at which the brass scale of Troughton is a standard, is not of practical importance as far as making the copies is concerned. I am

not aware that the relative expansion of the original standard, and of the copies, has been determined. It will, however, be done before the work closes. The number used by Mr. Hassler for the expansion of brass, was derived from his experiments made at Newark, in 1817, recorded in the second volume, new series, of the American Philosophical Society's Transactions; it was for the proportional expansion, 0.000,010,509.03, or for expansion in one yard, 0.0003732508 inches for one degree of Fahrenheit's thermometer.

The temperature at which the original scale, supposing it to be an authentic copy of the British standard yard, is standard, is 62° Fahrenheit. If any other temperature is assumed as that at which the yard of the brass scale is the American standard, there is at once introduced an inequality between the American and British yards. Mr. Hassler does not, as far as I can find, assert that he adopts the melting point of ice as the standard temperature of the American yard, and the Secretary of the Treasury, in reporting the adoption of this scale as the standard from which the measures are to be made, does not state the temperature at which this was to be taken as the standard. There is no doubt that Mr. Hassler preferred the standard temperature of 32°, for which he repeatedly assigns reasons, and that he intended to have that temperature adopted. The question, however, is still an open one, and this is not the occasion for its discussion. For the present, I deem it sufficient to remark that the American standard will be nearest the standard to which it was intended to conform at the temperature of 62° Fahrenheit, or at that temperature nearly. That temperature also will be most convenient for making copies of the standards.

2. The *units of capacity measure* are the gallon for liquid, and the bushel for dry measure. The gallon is a vessel containing 58372.2 grains (8.3389 pounds avoirdupois) of the standard pound of distilled water, at the temperature of maximum density of water, the vessel being weighed in air in which the barometer is 30 inches at 62° Fahrenheit. The bushel is a measure containing 543391.89 standard grains (77.6274 pounds avoirdupois) of distilled water, at the temperature of maximum density of water, and barometer 30 inches at 62° Fahrenheit.

The gallon is thus the wine gallon of 231 cubic inches nearly, and the bushel the Winchester bushel nearly.

The temperature of maximum density of water was determined by Mr. Hassler to be 39°.83 Fahrenheit.

In adjusting the capacity measures, a table, differing but little from that below, was used, to correct for the differences of weights of water contained at different temperatures. It was obtained by interpolation from the tables given by Mr. Hassler in his report of 1842, and circular of 1843; and I have substituted for it one by a more rigid interpolation. I give this table, and the one which follows it, as convenient in the adjustment of county standards.

I cannot speak with authority as to the origin of the table from which this is derived; the investigations by which it was obtained, from experiment, not being among the archives of the office.

Table showing the difference between the apparent weight of the half bushel and gallon measures at different temperatures, and the weight at the temperature of maximum density of water, the standard temperature.

Temperature of adjustment.	CORRECTION FOR	
	Half bushel.	Gallon.
Farenheit °.	Grains.	Grains.
35	+45.65	+ 9.81
36	+32.81	+ 7.05
37	+21.24	+ 4.56
38	+10.93	+ 2.35
39	+ 1.87	+ 0.40
40	— 5.93	— 1.27
41	—12.47	— 2.68
42	—17.76	— 3.81
43	—21.78	— 4.68
44	—24.55	— 5.27
45	—26.31	— 5.65
46	—26.87	— 5.77
47	—26.02	— 5.59
48	—24.09	— 5.18
49	—21.09	— 4.53
50	—17.03	— 3.66
51	—11.89	— 2.56
52	— 5,69	— 1.22
53	+ 1.59	+ 0.34
54	+ 9.93	+ 2.13
55	+19.35	+ 4.16
56	+29.84	+ 6.41
57	+41.39	+ 8.89
58	+54.02	+11.61

The sign + indicates that, at the corresponding temperatures, the number of grains given in the table must be added to the apparent weight, to give the weight which the measure would contain at the temperature of maximum density of water, or that the measure contains less than the standard weight. The number of grains marked +, must be placed on the side of the balance where the measure is. The number of grains marked — are at the temperatures corresponding to the — corrections, to be placed on the counterpoise side of the balance.

The correction used for the height of the barometer, in adjusting the gallon measures, was 2.05 grains for one inch of the barometer; no change being made for variation in the temperature of the air or mercury. The corresponding correction in the adjustment of the half bushel was 9.54 grains. In obtaining these numbers, the specific gravity of air, at the standard pressure of 30 inches, and 62° Fahrenheit, was assumed by Mr. Hassler, as determined by Sir George Shuckburgh, $\frac{1}{1\,8\,3\,1}$; water at 62° being 1.000. The specific gravity of brass was taken by him, also at 8; water being 1. This led to the fraction, $\frac{1}{8\,3\,1} \times \frac{7}{8} \times \frac{1}{3\,0}$, which, multiplied by the weight of the water contained in the standard gallon, or half bushel, gave the correction for buoyancy, for a change of one inch in the height of the barometer. The table is as follows:

Correction for the variations of the barometer from 30 inches.

Barometer.	For the half bushel.		For the gallon.	
Inches.	Grains.	Difference for 0.1 inch 0.955 grains.	Grains.	Difference for 0.1 inch 0.205 grains.
32.	+19.09		+ 4.10	
31.5	+14.32		+ 3.07	
31.	+ 9.54		+ 2.05	
30.5	+ 4.77		+ 1.025	
30.	0.00		0.00	
29.5	— 4.77		— 1.025	
29.	— 9.54		— 2.05	
28.5	—14.32		— 3.07	
28.	—19.09		— 4.10	

The numbers are to be applied with their signs + and — as in the preceding table.

3. The *standard of weight* is the troy pound, copied by Captain Kater, in 1827, from the imperial troy pound for the United States mint, and preserved in that establishment. The avoirdupois pound is derived from this: its weight being greater than that of the troy

pound, in the proportion of 7,000 to 5,760; that is, the avoirdupois pound is equivalent, in weight, to 7,000 grains troy. The multiples, as well as sub-divisions, of the pound, are based upon this standard, the weight of which was determined by the best means attainable at that time, in grain weights, by Troughton, at the mint, and at the office of weights and measures, in presence of Mr. Hassler, and of the director of the mint, Doctor Moore. From these determinations resulted the pound weights of the office of weights and measures, which are, therefore, copies of the troy pound of the United States mint, or derived from it. The pound is a standard at 30 inches of the barometer, and 62° Fahrenheit's thermometer. The troy pound of the mint was found, in the comparisons of Captain Kater, to be heavier than the imperial troy pound by only .0012 of a grain.

The measures of length and capacity, and the weight just referred to, have been adopted by the Treasury Department, as standards for the measures and weights of the custom-houses of the United States, and reported as such to Congress, in 1832.* By an act of Congress of March 2, 1799, the surveyors of the customs are required, in January and July each year, "to examine and try the weights and measures, and other instruments used in ascertaining the duties on imports, with standards, to be provided by each collector, at the public expense, for that purpose."

The troy pound was declared to be "the standard and troy pound of the mint of the United States, conformably to which the coinage thereof shall be regulated," by an act of Congress of 19th May, 1828. In the joint resolution of June 14, 1836, the Secretary of the Treasury is "directed to cause a complete set of all the weights and measures adopted as standards, and now either made, or in the progress of manufacture, for the use of the several custom-houses, and for other purposes, to be delivered to the governor of each State in the Union, or such person as he may appoint, for the use of the States respectively, to the end, that a uniform standard of weights and measures may be established throughout the United States." In order further to secure this uniformity, Congress directed, in 1838, the preparation, and distribution to the States, of balances for adjusting weights and capacity measures. No direct legislation has, as far as I am aware, taken place in the adoption of these, or any other, standards of weights and measures for the United States.

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*Report from the Secretary of the Treasury, (Hon. S. D. Ingham,) relative to a comparison of weights and measures, as used at the several custom-houses of the United States, which was required by a resolution of the Senate, of May 29, 1830, March 3, 1831.

2. Report from the Secretary of the Treasury, (Hon. Louis McLane,) in compliance with a resolution of the Senate, showing the result of an examination of the weights and measures used in the several custom-houses, &c., July 2, 1832, transmitting a report of the examination by F. R. Hassler, esq.

3. Report from the Secretary of the Treasury, (Hon. Louis McLane,) on the subject of weights and measures, in further compliance with a resolution of the Senate, June 30, 1832, transmitting the second part of Mr. Hassler's report, showing the means employed in the comparison of the weights and measures.

Opinion in regard to the proper action upon the provision of the constitution, authorizing Congress to "fix the standard of weights and measures" has, as far as it can be gathered from reports in Congress, and of the Executive to Congress, undergone several changes and modifications. Mr. Jefferson, in 1790, when Secretary of State, presented, upon a call of the House of Representatives, a "plan for establishing uniformity in the coinage, weights, and meesures of the United States." Two modes were embraced in this plan, one on the supposition that the weights and measures, then in common use, were to be retained, but to be rendered uniform and invariable by referring them to the same invariable standard; the other that a thorough change should be made in the whole system, the decimal ratio being adopted in the weights and measures, as it had already been in coins. The first mode included several changes in the values of the weights and measures themselves, the adoption of the same unit for liquid and dry measure, of the same unit for weight, the connexion of the capacity measures and weights through the weight of a given bulk of distilled water, the determination of the unit of length from the second's pendulum rod. By the second mode the change would have been nearly as thorough as in the coinage, certain denominations being retained while their values were changed.

The report of Mr. Izard to the House of Representatives, in 1791, postpones action in consequence of movements in England and France, the avowed object of which was to introduce uniformity in the weights and measures of commercial nations. In the following year, (1792, 1st session, 2nd Congress,) Mr. Izard made a report adopting Mr. Jefferson's second mode without alteration, and providing that the scientific comparisons required by the system should be made.

The attention of Congress was called in 1795 to the French system of weights and measures, by a message from the President, transmitting information communicated by the French minister. This message, and the report of Mr. Jefferson, were referred to a committee of the House of Representatives, (1796, 1st session, 4th Congress,) of which Mr. Harrison was chairman, who proposed the adoption of the foot and of the pound avoirdupois "now in use," as units of length and of weight, the connexion of measures of length and capacity, and of weight, and provided for the experiments necessary to make this connexion, and to refer the standard of length to the second's pendulum.

In 1804, the legislature of the State of Pennsylvania, requested the representatives of the State to endeavor to effect the passage of a law fixing the standards of weights and measures.

A committee of the House of Representatives, of which Mr. Lowndes was chairman, was appointed at the second session, of the 15th Congress, (1819,) to inquire into the expediency of fixing the standards of weights and measures. This committee were unanimously of opinion that the subject should not be left to "uncertain usages, or to the various laws of particular States," and recurred to Mr. Jefferson's first mode as that most desirable for

adoption, namely, to render uniform the measures and weights already in use. They proposed accordingly to procure "models of the yard, bushel, wine gallon, and pound supposed to conform to those in most common use in the United States, which, on proving satisfactory to Congress, might be declared to be standards of measure and weigh's of the United States, copies of them to be distributed to the States." Variations from certain of the ordinary denominations, the usual connection of the weights and measures, and comparison of the standard of length with the pendulum were recommended.

By a resolution of the Senate, adopted 3d March, 1817, the Secretary of State was requested to prepare and report, a "statement relative to the regulations and standards for weights and measures, in the several States; and relative to the proceedings in foreign countries for establishing uniformity in weights and measures, together with such propositions relative thereto, as may be proper to be adopted in the United States."

This resolution called forth the learned and elaborate report of John Quincy Adams, in 1822, in which, excluding for the then present, all innovations, he looked to the future to obtain that universal uniformity, which was not then practicable. "The two parts of the plan submitted are presented distinctly from each other, to the end that either of them, should it separately obtain the concurrence of Congress, may be separately carried into execution. In relation to weights and measures throughout the Union, we possess already so near an approximation to uniformity of law, that little more is required of Congress for fixing the standard, than to provide for the uniformity of fact, by procuring and distributing to the executives of the states and territories, positive national standards conformable to the law. If there be one conclusion now more clear than another deducib e from all the history of mankind, it is the danger of hasty and inconsiderate legislation upon weights and measures. From this conviction, the result of all enquiry is, that while all the existing systems of metrology are imperfect, and susceptible of improvement, involving in no small degree the virtue and happiness of future ages; while the impression of the truth is profoundly and al ost universally felt by the wise and the powerful of the most enlightened nations of the globe; while the spirit of improvement is operating with an ardor, perseverance, and zeal, honorable to the human character, it is yet certain that, for the successful termination of all these labors, and final accomplisment of the glorious object, permanent and universal uniformity, legislation is not alone competent. A concurrence of will is indispensable to give efficacy to the precepts of power. All trifling and partial attempts of change in our existing system, it is hoped, will be steadily discountenanced and rejected by Congress, not only as unworthy of the importance of the subject, but as impracticable to the purpose of uniformity, and as inevitably tending to the reverse, to increased diversity, to inextricable confusion."

Into this form the subject appears to have been permanently moulded, to fix for the present provisional standards, conforming to those in common use, rejecting trivial innovations, and looking

to the future for rendering possible the adoption of common standards among nations. Efforts were accordingly made from time to time to obtain positive standards conforming to those in general use.

The report of Mr. Adams, was referred to a committee of the House of Representatives, of which Mr. Lowndes was chairman, who reiterates (1822, 1st session 17th Congress,) the propositions of his previous report, adopting the principles of the first mode proposed by Mr. Jefferson, and agreeing generally in the practical conclusions of Mr. Adams. The resolutions offered by the committee, provide for the preparation and distribution of standards of weights and measures on a liberal scale, including all the important denominations in common use, for which standards can be made.

On motion of Mr. Woodbury, in 1830, the Senate of the United States unanimously directed a comparison, under the authority of Secretary of the Treasury, of the standards used in the custom-houses, which was made by F. R. Hassler, esq., and reported in 1832. The experiments and researches of Mr. Hassler, furnished all the information necessary to advance in this subject, in the direction given to it. The alleged discrepancies of the weights and measures, used in the collection of the revenue, were proved conclusively to exist. Weights and measures, collected from authentic sources by Mr. Hassler, furnish materials for extended comparisons; the length measure obtained by him as a standard in the coast survey gave a unit conforming generally, to the original of our length measure; the Troy pound of the United States Mint, gave an authentic unit of weight. Mr. Hassler's researches served to connect the standard of measure and of weight, by the weight of a given bulk of distilled water, at its temperature of maximum density, and thus to regulate the capacity measures, so as to conform to the originals of the standards of liquid and dry measures in general use. It remained, then, to multiply and distribute copies of these standards. The difficulties of Mr. Hassler's undertaking do not seem to have been fully appreciated, nor the resources of scientific and mechanical skill required for success. The amount of work to be done was very much underrated, and the expense, and time required for its accomplishment greatly under estimated. It is obvious to one succeeding him, that his resources were much crippled by the state of opinion. He had materials, tools, and workmen, to collect for a branch of art entirely new in our country; processes to invent, and modes of scientific experiment to reduce to process of art. All this, under the constant pressure of the opinion that there should be greater promptness in doing that which human hands in the numbers consistent with joint annual expenditure and adequate skill, could not accomplish, except at a certain rate. Much that was attempted by hand should have been done by machinery, but, the necessity for delay to produce the machine not being recognized, hand processes, which, in the long run, are the most costly, were resorted to, leaving the machine to be made at a late day, or, losing eventually, the advantage of the perfection which it would have given. When it was once determined to produce uniformity in weights and measures by distributing au-

thentic standards, the expense and time required for the execution of the design were mere incidents. The weights and measures are only valuable in proportion as they are exact, and accuracy is to be attained only through skill and time, both of which imply expense.

The steps in legislation by which Mr. Hassler's labors were directed and, from time to time, increased, have already been stated. In the second session of the 23d Congress, Mr. Binney, from a committee of the House of Representatives, to which the subject had been referred, reviews the powers of Congress in regard to fixing standards, clearly defining the bounds beyond which legislation should not extend, and looking to further legislation when copies of the standards shall have been distributed, as has now, to a considerable extent, been done. It appears to be generally conceded, in the later reports on this subject, that the power of Congress extends to declaring what the legal weights and measures of the Union are to which the laws refer, to requiring these standards to be used in the custom-houses, land surveys, and, in general, by officers under the authority of the United States in the execution of their laws, and not to prescribing how those weights and measures shall be used between citizens in their dealings. Whether the indirect sanction which has been given to the adoption of these provisional standards is not all-sufficient for such a purpose, and all of which they are worthy, it is for the wisdom of the law-making power to decide. I am opinion that the present weights and measures, whether declared to be provisional or not, will prove to be really so in the progress of our Union, and that arrangements more worthy to be called a system will one day prevail.

Of the balances.

Accompanying the last report of the late Mr. Hassler on weights and measures was a description by his son and assistant, Mr. E. Hassler, of the balance sent to the British government in 1843. This description specifically applies to the largest of the three balances constituting the set intended for the States. In general, however, the construction of the three was the same, the dimensions only differing as they were intended to regulate weights of different amounts.

Modifications in certain parts of these instruments, growing out of the experiments made in the construction and use of delicate balances in the mint of the United States, were proposed by Mr. Saxton soon after his appointment as assistant of weights and measures, in 1844, and after examination were approved by me. The changes admissible were within moderate limits, in consequence of the number of castings already made for these instruments. As these modifications have been made in the balances which have been sent to the States, and set up by Mr. Saxton, it is necessary that they should be briefly described; in doing which I will assume that the previous general description of the instrument is understood, and represent by a figure the general appearance of one of the large balances upon its stand, and with its glazed case, as it would

appear when mounted for use, (see plate I, figure 1,) and of the smallest balances, for adjusting light weights, similarly mounted, (see plate I, figure 2.) The details of construction, as far as essential to understand the working of the instruments, are presented in figures 3 to 10, plate II.

When in use, the balance beam is supported by a central knife-edge *k'* of steel resting upon a steel plate *e* on the head of the central column of the balance, (figure 1, plate I.) In Mr. Saxton's modification of the balance, this bed *e* is made moveable, vertically, upwards and downwards. When down, the beam rests at *m m* by steel cones *m*, which enter conical cavities in the small columns *m' m'*, resting upon the plates *l l*, (figure 3, plate II.) These bring the beam to its place if accidentally deranged, so that when the plate *e* is again raised, the knife-edge may rest in its proper position upon it. To raise or lower the plate *e* (figures 1 and 5,) a fork shaped slide *d d*, (figure 5, plate II.,) bearing the plate *e*, moves vertically between the cheeks of the head of the centre column, or main stem of the balance. A screw c fixed to the base of the forked slide connects it with a horizontal wheel *a*, through the centre of which the screw passes. The wheel *a* is toothed on its periphery, and into the teeth an endless screw *b* plays, turning the wheel on the screw, which passes through its centre, and thus raising or lowering the forked slide *d d*. The endless screw which gives motion to the horizontal wheel is attached to the axis *f*, (figure 3, plate II.,) which passes through the end column, and upon the extremity of which is the crank *g* to turn the axis, (figure 1, plate I., and 3, plate II.) This crank is removeable at pleasure, a socket upon the short horizontal arm fitting upon a square stem in which the axis *f* terminates. To stop the motion of the crank within the limits required for the upward or downward movement of the plate *e*, (figure 1, plate I.,) a screw is cut upon the axis *f*, near the end column, through which it passes, upon which is placed a nut *h* having a projecting pin on each end, and sliding on the edge of the front cross bar, which prevents it from turning with the axis. Two short arms or stops *i*, one at each end of this screw, are also fast upon the axis, and against one of these one of the end pins of the nut touches, when the axis is turned sufficiently to raise or lower the bed, plate *e*, to its place.

The end knife-edges, which support the scales, admit of a slight adjustment, one in the direction of the length of the beam, the other transversely. The contrivances for these adjustments are of such a nature that they do not invite tampering with, but are difficult of access; as when once made, unless in case of accident to the instrument, the adjustments should be permanent. The end adjustment is effected by fastening the knife-edge at the right hand end of the beam in a slide *j*, (figs. 6 and 9, plate II.,) having a screw at each end, with a broad head notched, so as to receive a small lever for turning it. The opening in the beam for receiving the slide is made a little larger than the slide and screw head, so as to permit a small motion of the slide in the direction of the length of

the beam, when one screw head is turned in and the other out, in making the final adjustment of the length of the arms of the balance. The transverse adjustment is effected by inserting the knife edge at the left hand end of the balance in a bracket, (fig. 10, plate II.;) the circular part of which is made to pass through the beam. The knife-edges may thus be rendered parallel without grinding, and thereby altering the angles of the edges.

To raise the plates upon which the scales are supported upon the end knife-edges from these edges, when the balance is not in use, lozenge-shaped cavities *n* and *n*, (fig. 3, plate II.,) are made in the plates *l* and *l*, directly under the knife-edges. Into these the V-shaped wings *o* (figs. 1 and 2, plate I., and 4, plate II.,) drop as the beam descends, and the stirrup, and with it the bearing plate of the scale *o'*, is raised. The dropping of the wings *o* into the lozenge-shaped cavities *n*, serves also to bring the stirrup into proper position for the bearing of *o'* upon its knife-edge, if accidentally deranged.

The beam is brought into a horizontal position during the weighing, and stopped there by two pins *q*, (fig. 1, plate I.,) which slide vertically through brass bushes in the iron table or stand upon which the instrument rests. When raised they press against the bottom of the scale dishes. To give motion to these pins, a screw is inserted in the lower end of each, and the head of the screw is formed into a loop *r*, (fig. 7, plate II.) The screw provides a motion for regulating the height to which *q* rises. Under the iron table is an axis *s*, turning in brackets, and having two projecting arms *t*, the ends of which pass through the loops *r*. The handle *u*, attached to the axis near the middle, and projecting in front beyond the table, serves to gives motion to it. Upon the handle is a trigger *v*, (fig. 1, plate I.,) so arranged that when the beam is at its proper height, and the handle *u* is pressed down to bring the pins *q* against the bottom of the scale dishes, giving thereby the beam a horizontal position, the trigger catches on the edge of the iron table, and keeps the whole at rest until relieved by pressing the trigger and raising the handle *u*.

The final adjustment of the centre of gravity of the beam in the vertical and horizontal position is made by the apparatus *k*, (fig. 1, plate I.,) consisting of a vertical and horizontal screw attached to the beam just over the knife-edge, the horizontal screw having two arms. A ball turning upon the vertical screw serves to raise or depress the centre of gravity, and one upon each end of the horizontal screw, to carry it horizontally to the right or left.

In levelling the balance, the spirit level should be placed on the plates *l*, attached to the cross-arms, (fig. 3, plate II.,) as the cast iron table may not be perfectly flat.

Each balance is enclosed in a wooden case, which has glazed doors in front, sliding vertically, with counterpoise weights, so that they move easily, and remain in any position in which they may be placed. The cast iron tables are covered with a black varnished cloth, highly polished, and having a stamped border. The crank *g*, (fig. 1, plate I., and 3, plate II.,) is removed from the end of

the axis *f*, and placed inside of the case. The case is locked, and the key accompanying it duly labelled. Labels are also placed conspicuously in the case, requiring that the instrument be not handled except for use, in adjusting weights and capacity measures.

The working parts of steel are gilded by the electrotype process, to preserve them from rust. The gilding is removed from the supporting edge of the knife-edges by a hone.

The balance should be used to adjust weights or capacity measures in the following manner: Bring the beam down, until it rests upon the supports *m'*, *m'*, by the cones *m*, *m*, (fig. 1, plate I.,) if not already in that position, by turning the crank *g* backward (so as to carry *h*, fig. 3, plate II. towards the centre) until the stop prevents further motion. Place the standard weight in the right hand dish, and a counterpoise in the left, taking care to place each in the middle of the dish; then raise the beam, by turning the crank forward, until it is stopped, when the beam is at its proper height; pass the handle *u* down until, by the rise of the pins *q*, to touch the scale dishes, the beam is rendered horizonal, the index at each end of the beam pointing to the centre, or zero line of the ivory scales attached to the end columns; detach the trigger *v*, and raise the handle *u*, when it will be seen which end of the balance preponderates. Add small weights to the lighter end, bringing the beam, from time to time, into a horizontal position, and stopping thus the vibration of the balance until an equipoise is effected; then let the beam down, by turning the crank *g;* take off the standard weight, and replace it by the weight, or capacity measure to be adjusted. Before taking off any portion of the weight from either side of the balance, the handle *u* must be pressed down until the trigger catches, to prevent the beam from tilting suddenly, and injuring the knife-edges by the blow.

It would greatly facilitate the operation of adjusting weights, and preserve the standards, if a set of counterpoise weights were made, a little lighter than the standards, so that the small weights would always be on the disk with the counterpoise. All danger would thus be avoided of disturbing the small weights, when the standard is removed and replaced, by the weights to be adjusted.

The small balance, to be used only in adjusting weights of one pound, or less, is shown in figure 2, plate I. It is represented as ready for use, resting on a cast iron base, with a cover, having a glass front sliding upward, and duly counterpoised. The arrangements are, in general, those referred to above; the apparatus for lowering and raising the beam differs, however, from that already described. The arrangement is shown in figure 8, plate II., which is a section of the centre column and table upon which the balance re sts *x* is a snail-shaped piece of brass, fixed on the axis of the milled head, *w*. *y* is a steel rod, connected with the forked slide, *d d*, which, passing through the table, rests upon the snail, *x*, so that, by turning the milled head, *w*, backward or forward, the slide is raised or lowered. There are stops, limiting the motion of the milled head. There is no trigger to the handle, *u*, for bringing

the beam to its horizontal position; the pins, *q*, being allowed to slide away from the bottom of the dishes, by their own weight; when, then, it is desired to check the vibrations of the beam, the finger must be kept upon the handle for a short time, so as to keep up the pressure of the pins, *q*.

In adjusting with this balance, the milled head, *w*, is turned, either in raising or lowering the beam, with a steady motion, until the stop is felt. The glass door may be kept partly open until the equipoise is nearly effected, when it should be closed, and the beam be brought to a horizontal position by a gentle pressure on the handle, which should be kept up for a short time, until motion has probably ceased in the air within the case. Vibrations of the beam may be readily checked by pressing the handle, *u*, at intervals, two or three times, by which the pins, *q*, will be brought against the bottom of the dishes.

A balance for weighing silver was made for the branch mint at New Orleans, by request of the director of the United States mint, (Dr. R. M. Patterson,) and by authority of the Treasury Department. This balance is required to weigh large weights with accuracy and despatch, and to permit rapid and easy manipulation of the instrument and substance to be weighed. It is desirable that the results of the weighing should be visible by two persons without interference with the operator, as by the officer of the mint who weighs a deposite of bullion, and by the depositor. The experience of Mr. Saxton, as balance-maker in the mint of the United States, at Philadelphia, and his familiarity with the operations there, have enabled him to know the relative importance of all the conditions in the construction of such a balance. The drawings of the instrument, shown on plate III., were made by Mr. Saxton; the patterns, castings, &c., under his direction, and the whole balance finished and adjusted by him, or under his immediate care. It will only be necessary to notice such parts of this instrument as are peculiar to it. Plate III. shows the balance and its parts, the figures being drawn to a scale of one-eighth of the real dimensions, except figure 6, which is on the scale of one-fourth. The same letters denote the same pieces on each figure. Figure 1, gives a side view of the instrument; figure 2, a top view of the trussed frame DD; figure 3, an end and top view of the apparatus for raising and lowering the trussed frame; figure 4, a top view of the scale-pan for weighing coin; figure 5, a top and side view of the dish for weighing metals in bars or bulk; and figure 6, shows the apparatus for bringing the beam to rest in a horizontal position in weighing.

The balance rests upon a cast iron table, A, (plate III., figure 1,) intended to be supported at the back and ends upon a brick wall built for the purpose. The beam C is supported on the columns B, and their entablature, a projection carrying the steel plate upon which the knife-edge of the beam rests. The truss frame DD has a vertical motion, sliding upwards; the cups, shown in the figure, receive the two steel cones on the beam. Motion is given to this piece through two iron rods EE, which, passing down the axis of the columns, are connected below the cast iron table by a curved

piece, F. The rods slide through openings in the caps of the columns, and in the table, which they fit accurately. An eccentric is turned upon one end of the axis G, (plate III., figures 1 and 3,) which rests in bearings under the table A. This eccentric passes through one end of the connecting piece I, the other end of which is attached to the curved piece F, by the bolt J, so that by turning the crank H of the axis G through half a revolution, the requisite motion, upwards or downwards, is given to the trussed frame. A top view of the trussed frame is given in figure 2, plate III. It shows the lozenge shaped cavities through which the shanks of the stirrups pass, and in which, when the frame rises, the wheels L rest, relieving the knife edges supporting the scales. The weight of the scale, and of the iron frame, is thus borne by the trussed frame when the balance is not in use, or, in general, when the knife-edges not touching the plates against which they press when the instrument is in use.

This arrangement, the lozenge-shaped cavity on the trussed frame, and the wheel on the shank of the supporting stirrup of the scales, secures also the correct position of the bearing lines of the plate against which press the knife-edges supporting the scales.

The arrangement for bringing the beam to rest in a horizontal position, is shown in figures 1 and 6. U is a stop below each scale-pan, the shank sliding accurately through the bush, V. This stop is raised to touch the bottom of the pan by a handle, Q, and a lever, R, of which P is the axis. The lever acts through the connecting piece S (figure 6) and screw T, which, working in the dish-seat U, serves to adjust its distance from the bottom of the dish, so that when the handle Q is pressed down until the stop screw W touches the under side of the table, the dish-seat or stop is just in contact with the dish when the beam is horizontal.

The hollow dish, M, for weighing coin, is shown in figures 1 and 4. The flat dish for weighing the metal in bars or in bulk, is shown in figure 5. The handle of this dish is made to fit the clasp O, (figure 1,) of the dish M, which it replaces. The clasp is so constructed, that it opens on lifting the dish, and is kept open by a spring until the dish is returned to its place, and the clasp is closed by the finger. The dish M was made of an alloy of 15 parts of brass, 12 of copper, and 1 of tin, which takes a beautiful gold color by slow and moderate heating; the brass referred to consists of 3 parts of copper and 1 of zinc and 1 oz. of tin to the pound of alloy. When the temperature of this alloy has been raised to the point requisite to give the gold color, the metal oxidizes very slowly at ordinary temperatures. To adjust for the wearing of the scale dishes by use, a small cup in the form of a screw head is placed under each of the flat dishes which hold the weights in using the balance, containing a number of small brass rings, any portion of which may be removed to correct for the wearing of the hollow dish.

A cloth cover serves to protect the balance when not in use. It connects two frames of wood, the upper one of which is fixed above the balance to the ceiling of the room in which the instrument is

used, and the lower one rests on the cast iron table. The lower frame is raised, forcing the cloth in folds before it, by cords fastened at the four ends passing over pulleys, and uniting in one at the side of the room. It has a weight attached to it, to counterpoise the weight of the lower frame and cloth.

In using this balance when beginning to weigh, the crank H (figures 1 and 3,) should be to the right hand, so that the trussed frame may bear the weight of the beam and scales, and the knife-edges may not be in contact with their plates. The weights should then be put on, the dish lifted off and filled, then hooked upon the clasp O. The handle (figures 1 and 6) is then pressed down by the left hand, and the crank H is turned to the left by the right hand. The handle is then raised, and the side upon which the beam preponderates is seen. The divided scale, along which the index moves, is graduated on both sides, so that the officer and depositor may both see the result of the weighing.

When the first balances were ready to be sent to the States, I obtained from the Hon. John C. Spencer, then Secretary of the Treasury, a list of the States to which it was desirable first to deliver them, and forwarded to the executive of each a circular, of which a copy is hereto appended, (appendix,) calling attention to the fact that the balances were ready for distribution. At the same time I was authorized to instruct Mr. Saxton to deliver the balances in person, to see that they were in good condition, mount them, and explain their use to the State superintendent of weights and measures, or other person in whose charge the instruments were placed by law or by executive action.

In order to use these balances satisfactorily, they must be placed upon a firm foundation. To adjust standard weights and capacity measures, or to make copies of a kind which would be of service for county standards, a room is required which does not change its temperatures rapidly, and without draughts of air. To copy the standards of length, the same condition as to temperature must be fulfilled, and besides the light must be suitably admitted. These conditions require a room or building of a certain character for using the instruments. The dimensions are determined by the number and character of the standards and of the balances. The safety of the instruments require that they should, if possible, be in a fire-proof building. The balances and the standards of weights and measures form quite a valuable collection of instruments; they have been prepared at considerable cost, and are worthy of careful preservation. A plan of a fire-proof building or room in which to preserve and use the standards and balances, was prepared by Mr. Saxton, and was engraved for transmission with the circular letter before referred to. It also accompanies this report, plate IV.

It is much to be desired that the adjustment of the standards for the counties in the different States shall be in the hands of scientific persons, used to physical experiments of the more refined sort. This is the case in some of the States, affording the best security

that no considerable error will occur in adjusting the county standards, which should, by no means, be roughly done.

The frequent change of such officers when the duty is discharged by a State officer having other general functions, by which the information transmitted, or personal interest in the preservation of the standards is lost, is sure to be injurious. These considerations induce me to recommend a scientific custody of the instruments, and the recommendation has, in some cases, been adopted.

Finding that applications were not received for the balances more rapidly than they could be made, I addressed a circular similar to the one before referred to, to the executives of the different States, and have supplied the instruments in the order in which they have been applied for.

In 1845 and '46, Mr. Saxton put up the balances for the State of New Jersey, at Trenton; for New York, at Albany; and for Massachusetts, at Cambridge; and in 1847, set up those for Ohio, at Columbus; and for Delaware, at Dover. Last autumn, I transferred the balances of the State of Massachusetts from Cambridge to the State house at Boston, by request of the secretary of the commonwealth, (Hon. John G. Palfrey,) under the law directing the transfer. Applications have been received from the States of Maryland, South Carolina, and Texas, for the delivery of the balances prepared for them. Those for Texas have been sent under the charge of Assistant R. H. Fauntleroy, of the coast survey, who will attend to the mounting of the instruments. The others will be forwarded as soon as Mr. Saxton's services can be spared for the purpose.

In 1846, the balances of the second and third sizes were in the course of construction, enough of those of the first class having been made to supply the immediate demand. In 1847, those of the first and second sizes were making. Besides this regular work, a large balance for the New Orleans mint was made, which required new patterns, and, being a new instrument, occupied more time than two balances of the first class would have done.

Assuming thirty-four balances of the first and second classes, and thirty-six of the third as the whole number in the course of construction, the following tables show, with some exactness, the progress of the work. They are founded upon the same classification as that used in my report of 1846, correcting the data in the relative estimates of value in the different pieces, or processes, where experience seemed to indicate the necessity for it. The whole number of pieces is taken, supposing the entire series of balances to be of Mr. Saxton's construction.

After the rough castings of the parts of the balances are made, and the rough filing is executed, as far as practicable, by the laborers, the pieces for a number of sets are taken up and carried through the different processes of smooth filing, or turning, fitting, grinding, polishing, &c., until they are finished and ready to put together. Several instruments are thus in progress at once, and, when the parts are complete, they are assembled, and each instrument is placed in its case, and adjusted.

In the annexed table the operations are classed as 1, rough casting; 2, from the casting to rough filing; 3, from rough filing to smooth filing or turning; and 4, from this to finishing. There the putting up is separately estimated:

Progress of the balances for the States in 1846.

Classification of pieces.	Rough casting.	Cast to rough filed.	Rough filed to smooth filed or turned.	Smooth filed or turned to finished.	Per cent. of the whole number of pieces.				Progress in balances of this class, per cent., including setting up, &c.
					Cast.	Cast to rough filed.	Rough filed to smooth filed.	Smooth filed to finish'd.	
SECOND CLASS BALANCES.									
First class pieces.....	108	47	179	126	18	08	31	22	
Second class pieces.....	642	207	618	428	25	08	24	17	
Third class pieces.....	396	433	1,096	1,088	07	08	21	21	26.6
THIRD CLASS BALANCES.									
First class pieces.....	...	...	73	118	..	..	13	21	
Second class pieces.....	...	...	218	210	..	..	11	11	
Third class pieces.....	...	...	550	264	..	..	37	17	12.6

In estimating the progress, in per cent., relative values are assigned to the operations, which, if not entirely correct, are sufficiently so to give approximation to the results. Pursuing this same plan in estimating the relative values of the labor bestowed on the different classes of balances, the results given above come to nearly thirteen per cent. of the whole work, or rather more than one-eighth.

The number of the different classes of balances executed in two years, 1844 and 1845, being known, the number in 1846, and the number in 1847, data are furnished for estimating, approximately, the relative amount of time required to make a balance of each class.

The result of the progress above stated is nearly equivalent to the execution of nine balances of the second class, and four of the third, except the castings and rougher parts of the work, in 1846.

The following table, which is similar to the one just given, shows the progress of the balances in 1847:

Progress of the balances for the States in 1847.

Classification of pieces.	Rough casting.	Cast to rough filed.	Rough filed to smooth filed or turned.	Smooth filed or turned to finished.	Per cent. of the whole number of pieces.				Progress in balances of this class, per cent., including setting up, &c.
					Cast.	Cast to rough filed.	Rough filed to smooth filed.	Smooth filed to finish'd.	
FIRST CLASS OF BALANCES.									
First class pieces.....	34	52	84	114	06	09	14½	20	
Second class pieces.....	..	250	615	575	..	14	24	23	
Third class pieces.....	..	472	1,644	1,318	..	09	32	26	19.1
SECOND CLASS BALANCES.									
First class pieces.....	..	28	28	57	..	05	05	10	
Second class pieces.....	..	162	302	212	..	06	12	08	
Third class pieces.....	..	143	464	511	..	02	09	10	14.8

This gives just thirteen per cent. of the whole work for the year's progress. A revision of the data might alter this somewhat, but not materially. It is more nearly correct than the estimate made from more crude materials in the report for the year 1845. It is about equivalent to the complete construction, within the year, of six balances of the first class, and of three of the second class.

Adding to the work shown in the foregoing tables, the construction of the balance for the New Orleans mint, and the miscellaneous business of occasionally adjusting weights or measures for the departments, the sum presents the production of the establishment as far as the workshops are concerned, for the past two years.

The labor of adjusting the compensating apparatus for measuring bases in the coast survey, of preparing a standard bar of about twenty feet in length, (six metres,) comparing it with the authorized standards in the office, determining its co-efficient of expansion by heat, and finally of comparing the base apparatus with this standard, has occupied a considerable share of Mr. Saxton's time and attention, as well as of my own. The details of these experiments will be given when they have been completed. There are so few opportunities of obtaining, at Washington, in the course of a winter, a tolerably stationary temperature near 32° Fahrenheit, that I do not yet consider the experiments for expansion of the standards wire bar as sufficiently numerous to settle very minute differences.

The experiments have been made with the reflecting pyrometer of Mr. Saxton, and in the new fire-proof building attached to the office of weights and measures. This delicate instrument is placed in a room expressly arranged for such adjustments, and mounted so as, at pleasure, to compare the base apparatus, or the standard yard measures. I propose to describe this form of the instrument in a subsequent report.

Eight sets of balances, viz: those for the States of *New Jersey*, *New York*, *Delaware*, *Ohio*, *Texas*, *Maryland*, and *South Carolina*, are either delivered, or arrangements have been made for their delivery at an early date; and there are several sets ready for delivery, to which fact I intend, at an early day, again to call the attention of the State Executives.

The whole number of balances finished, up to January, 1848, is eighteen, of the first class; nineteen, of the second; and thirteen, of the third. This does not, of course, represent the whole progress made in the work, as all unfinished parts are omitted in the estimate.

Since the date of my superintendence, the States of Texas, Iowa and Wisconsin have been admitted into the Union; adding more than nine months' work, for the balances alone, for these States; no provision being made by the law for supplying the territories.

Respectfully submitted:

ALEX. D. BACHE,

Superintendent of weights, measures and balances.

Hon. R. J. WALKER,

Secretary of the Treasury.

APPENDIX.

OFFICE OF WEIGHTS AND MEASURES,
Washington,

To his Excellency
The Governor of the State of

SIR: I have the honor to inform you that a large balance, being one of those intended for the adjustment of standard weights and capacity measures, to be furnished to your State, under act of Congress, is now ready for delivery, and would respectfully ask your directions as to the time and place of delivery, and as to the person who may be duly authorized by you to receive it. The balance now prepared is of the largest size, being contained, with its appendages, in five boxes, about 5½ feet long, and from about 3½ feet to 10 inches wide, and 20 to 10 inches deep. It will require a space of about 6 by 8 feet to set it up properly, and should be placed upon a firm foundation on a ground floor or partition, built of brick or other masonry. I append a drawing of a small building, which would be appropriate for the preservation and use of the standards of weights and measures, which have been, or are to be distributed to your State, and would respectfully recommend that such a one might be provided for these elaborate and costly standards. They should at least be preserved in a fire-proof building, and placed upon a very firm floor. When you are prepared to receive the balance, which is now ready for delivery to you, a person will be sent to set it up, and to explain its construction and use to the agent in whose charge you may place it. It would be desirable that a scientific gentleman, connected with some institution of learning in your State, should have the charge of the standards of weights and measures, and of the balances, and that they should only be used, under his direction, for the adjustment or verification of county or other standards.

By an answer, addressed to me at this office, you will oblige

Yours, very respectfully,

A. D. BACHE,
Superintendent of weights and measures.

Plate 1

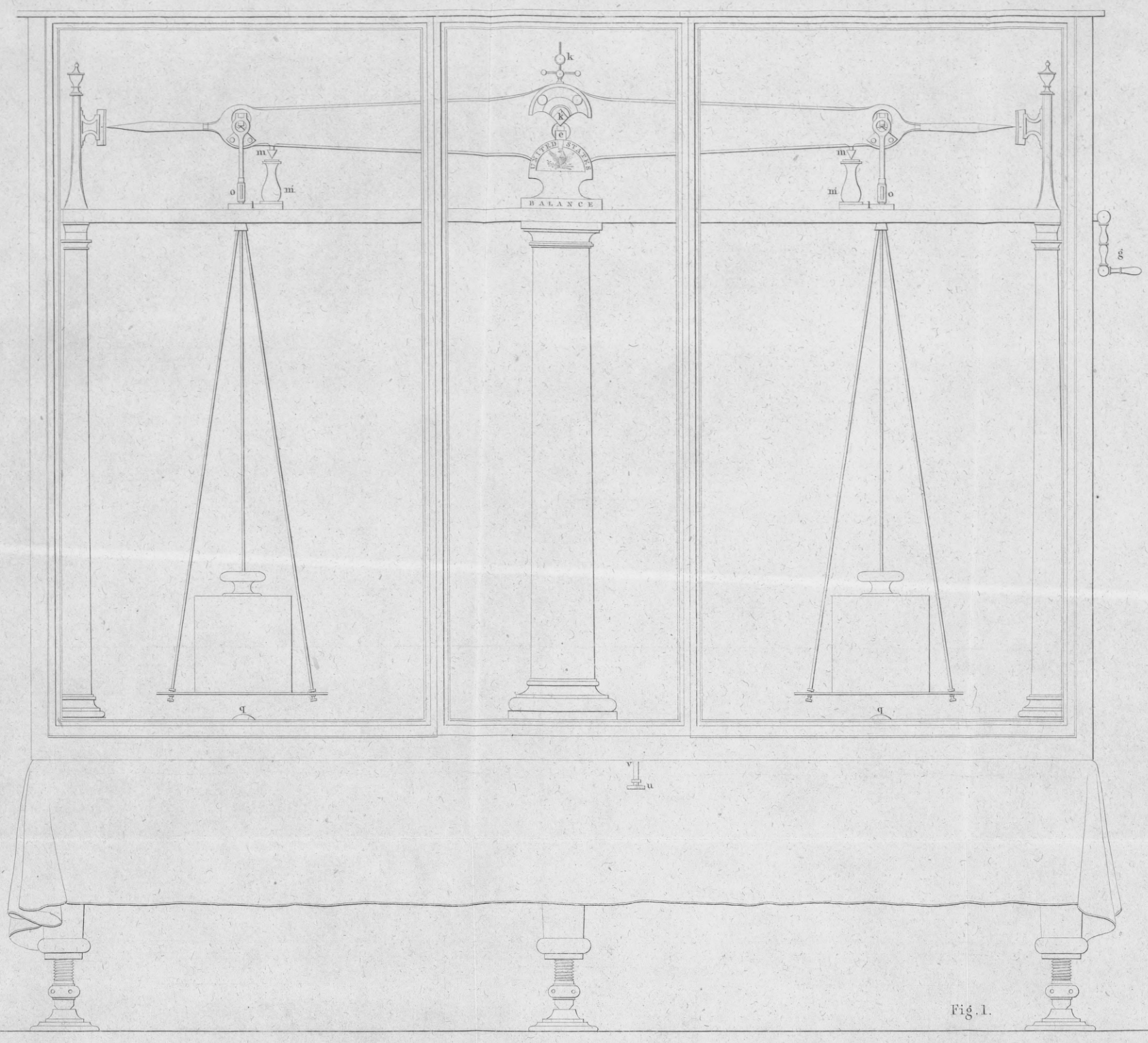


Fig. 1.

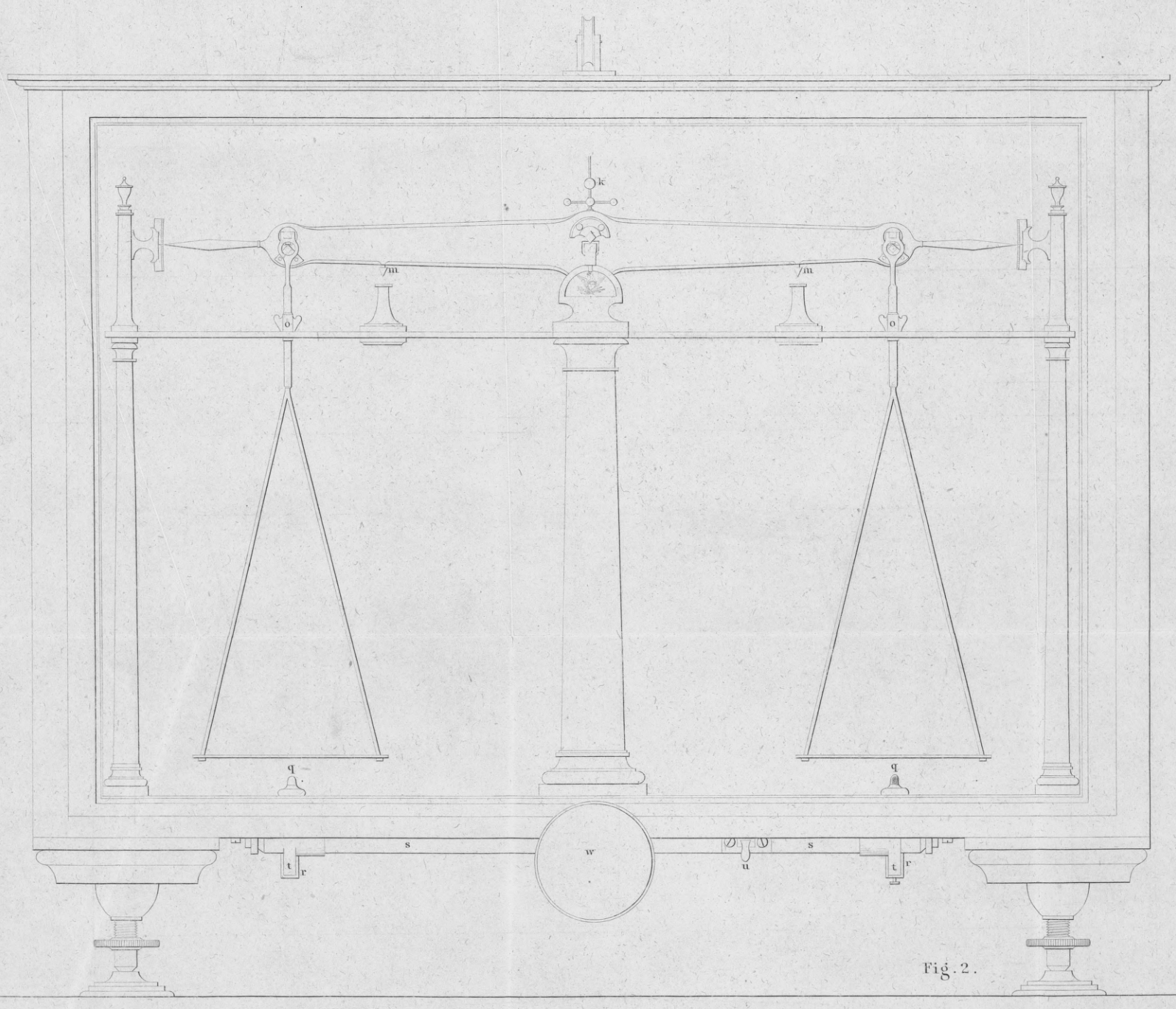
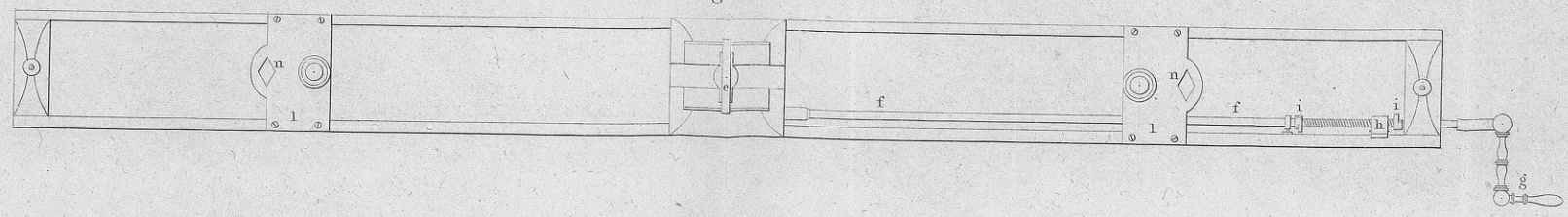


Fig. 2.

Plate 2

Fig. 3.



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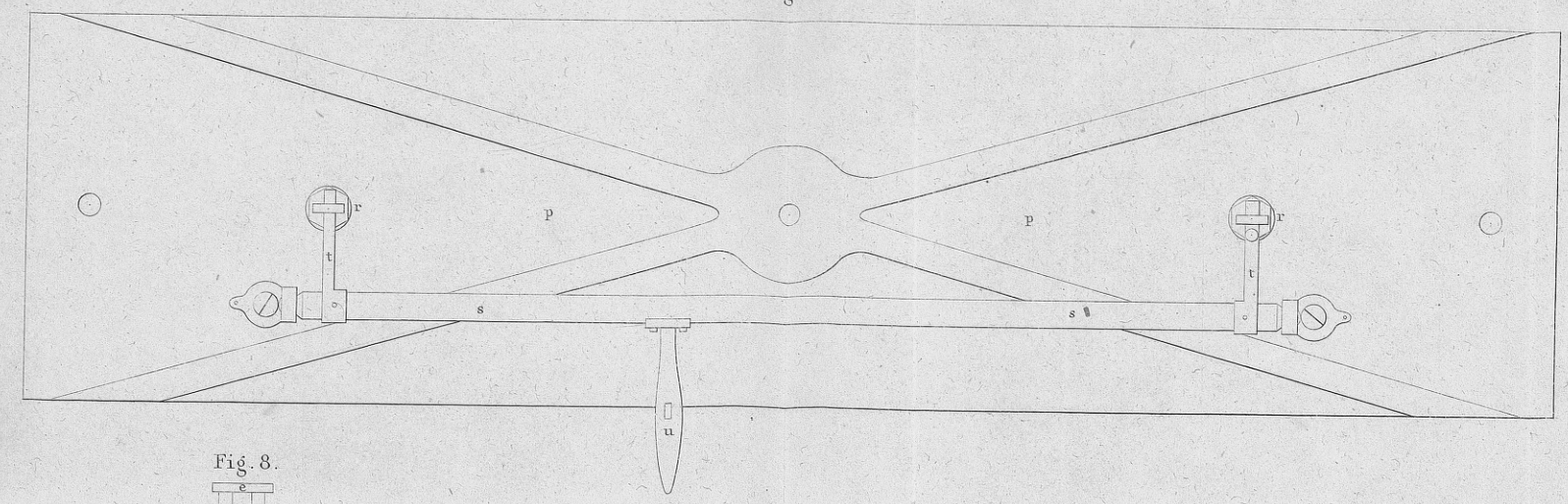

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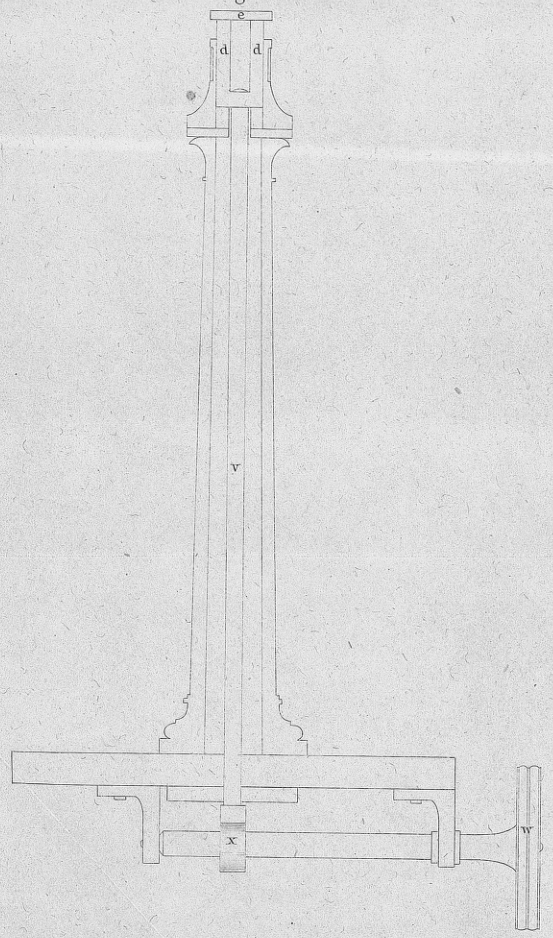
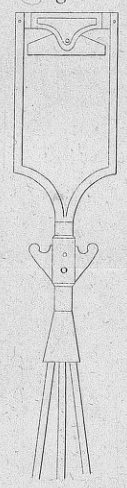


Fig. 4.



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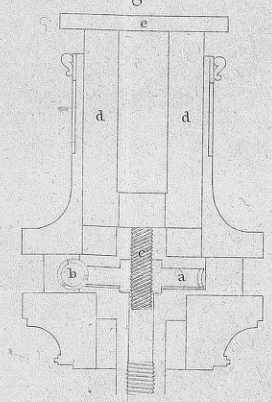

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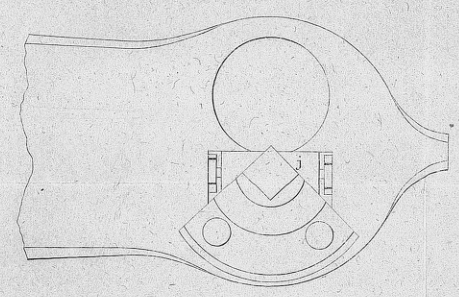

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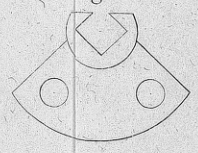

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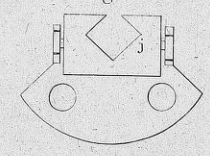

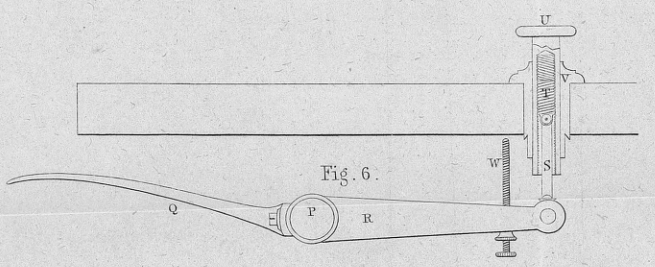

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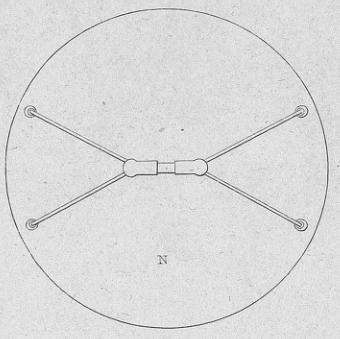

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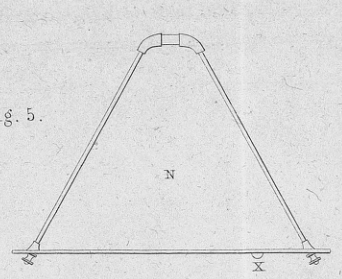

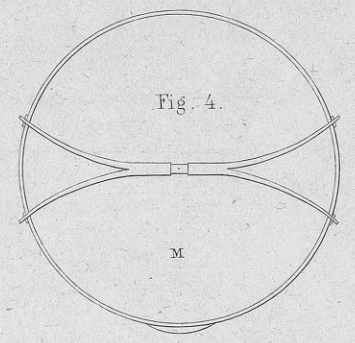

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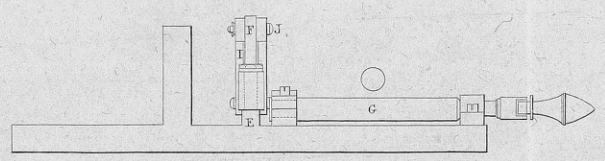

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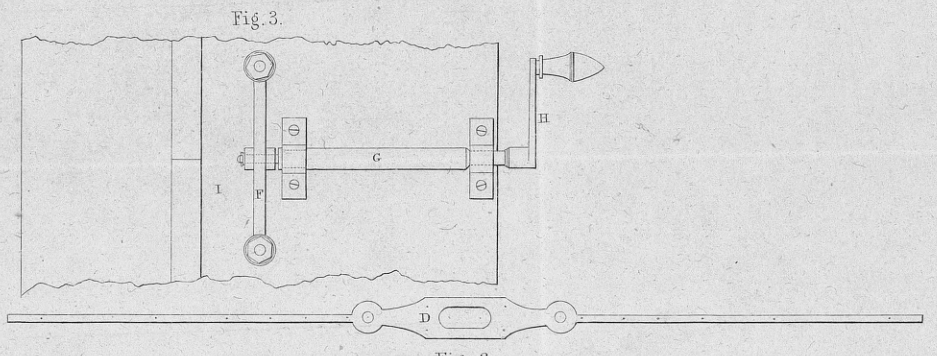

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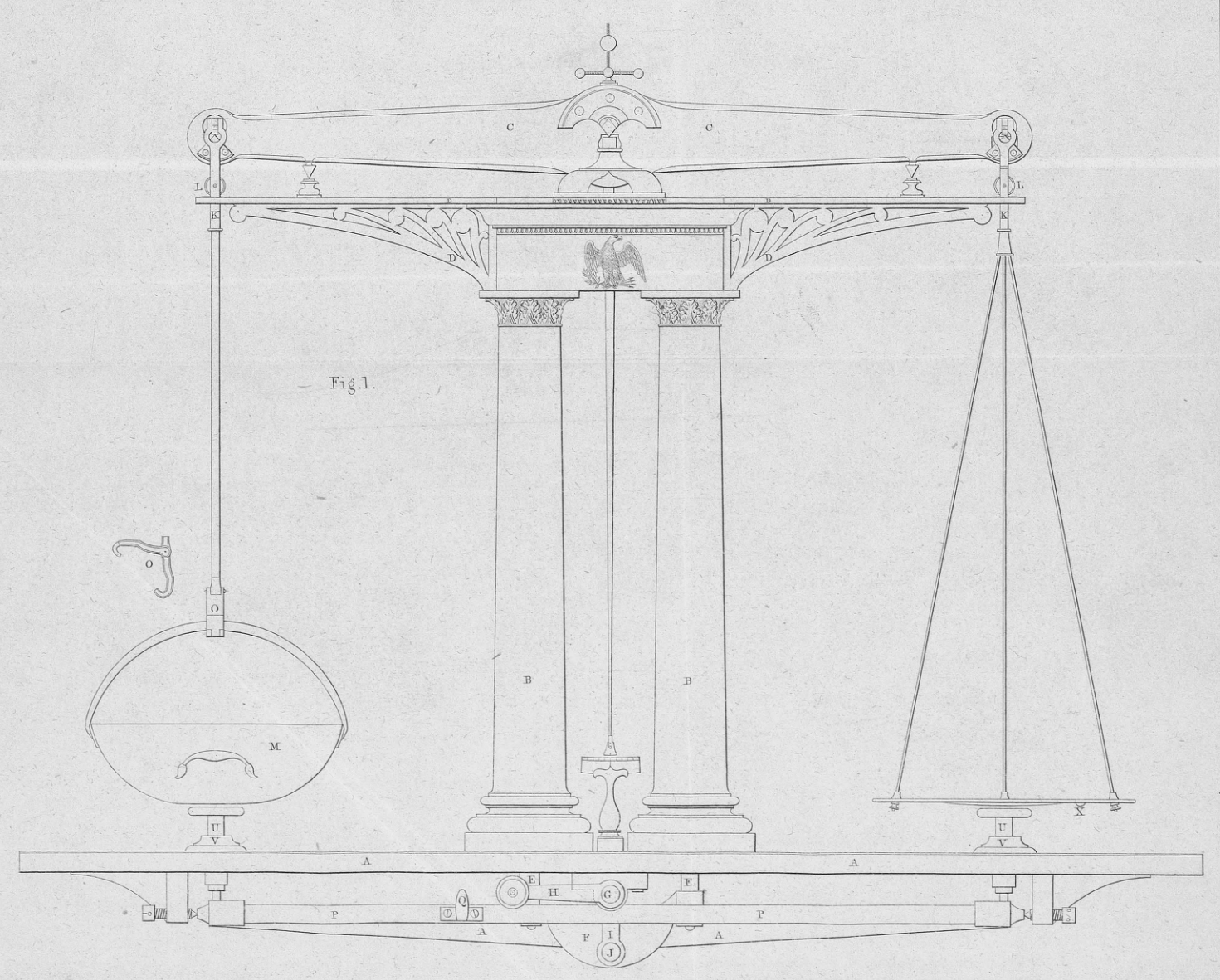

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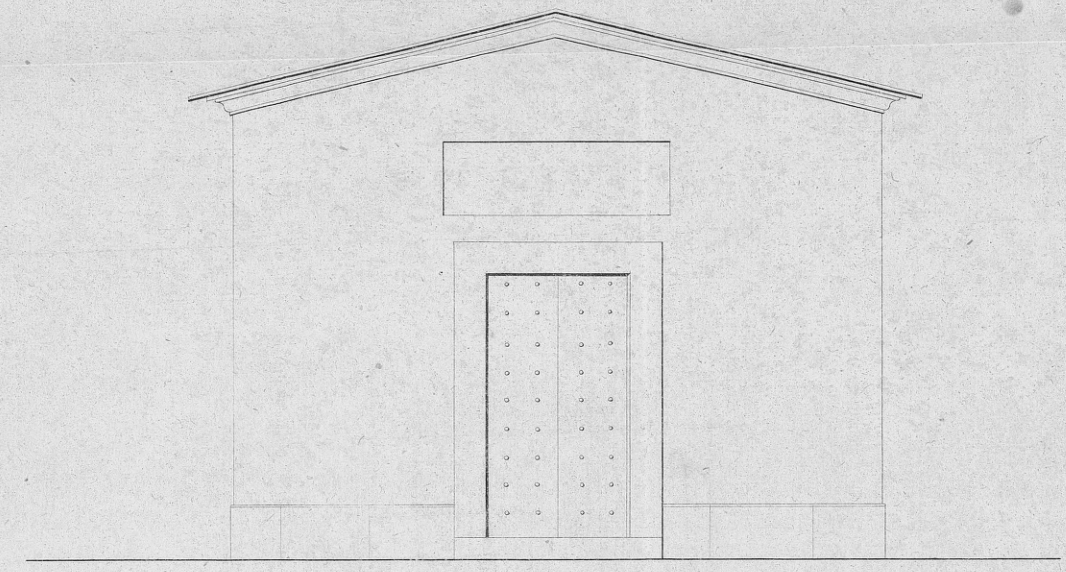
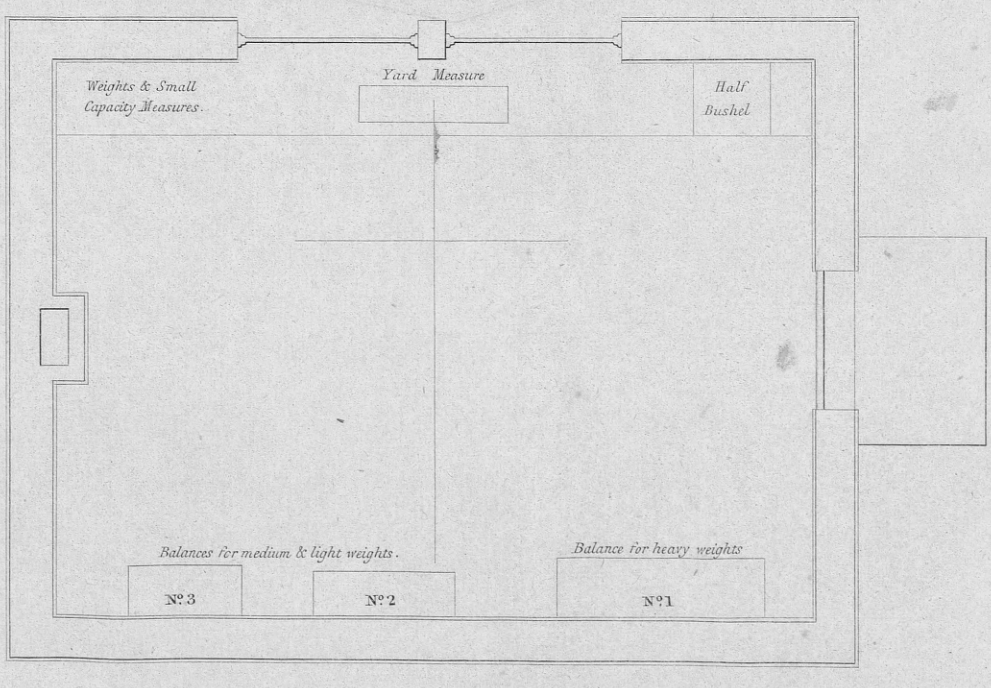


FRONT ELEVATION

SIDE ELEVATION



PLAN

Scale 5 Feet to an Inch.